



Yakima River Temperature Modeling

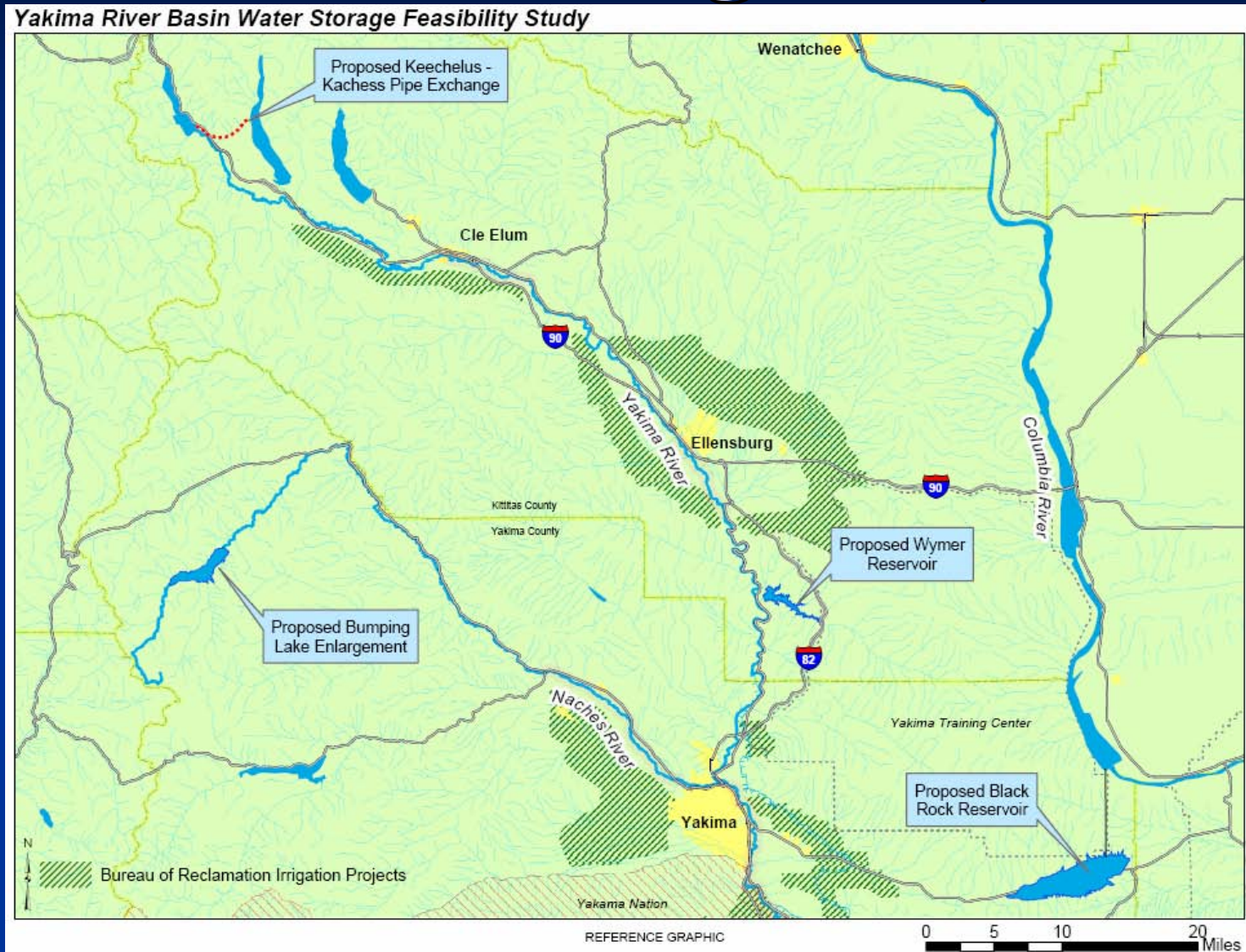
Purpose: Provide water temperature input to Reclamation's EDT (Ecological Diagnostic and Treatment) habitat model for the Yakima River to evaluate various water-storage alternatives as they affect fisheries on the Yakima River.

Scope: Yakima River Mainstem Reach from Roza Dam to Prosser

Today's talk: Water temperature monitoring at sites and longitudinal profiles, and the water-temperature model and preliminary results

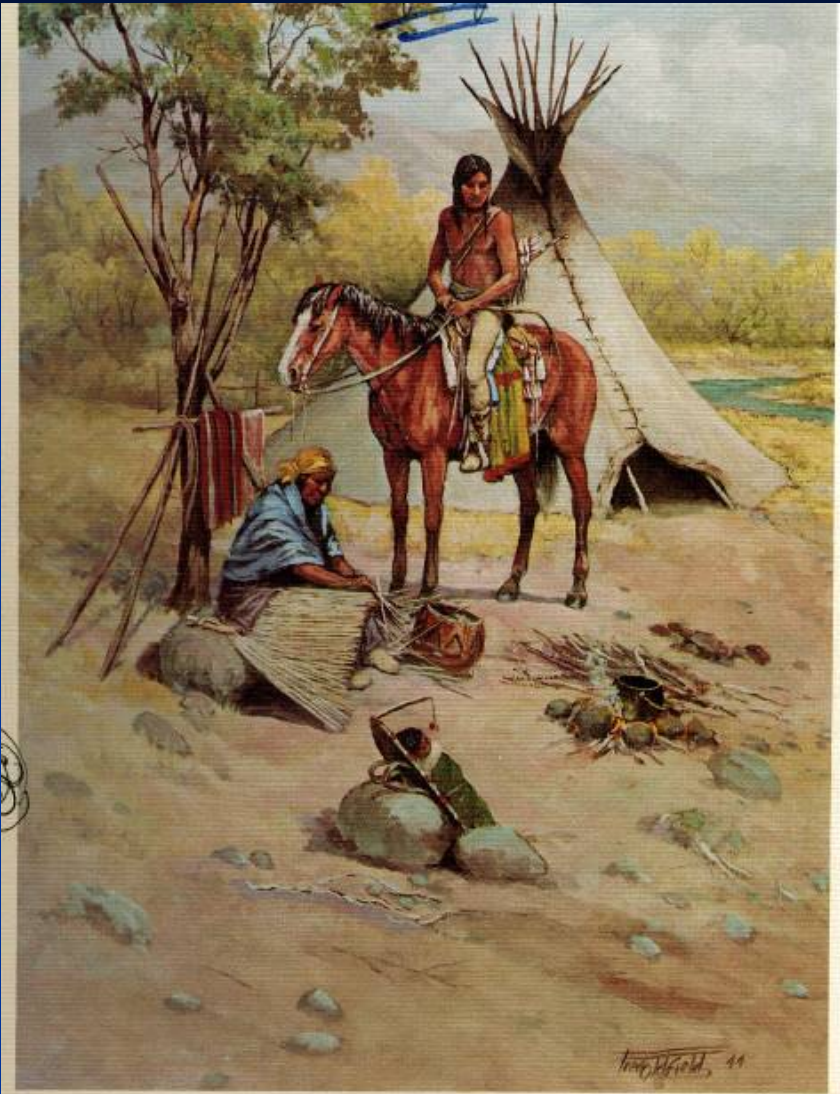
Mark Mastin, Frank Voss, and Chris Curran—USGS Washington Water Science Center

Yakima Storage Project



Currently USBR operates 5 reservoirs with a capacity of 1.06 M ac-ft. Irrigation demand is about 2.5 M ac-ft. Unregulated Runoff is about 4.0 M ac-ft. Storage Projects: Wymer (174,000 ac-ft) and Black Rock Reservoir (1.3 M ac-ft).

Previous Study by John Vaccaro



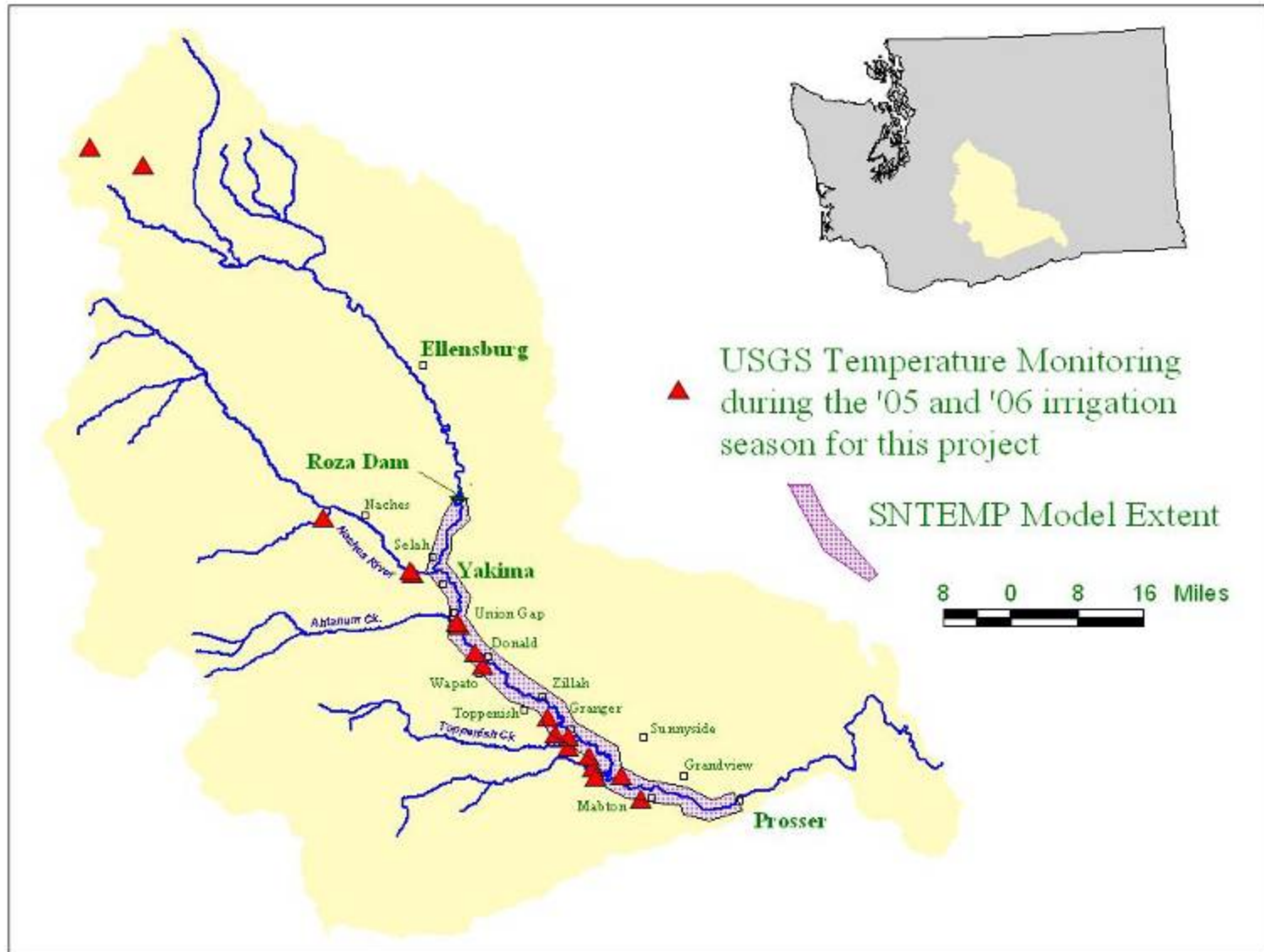
**Simulation of Streamflow Temperatures in the
Yakima River Basin, Washington,
April-October 1981**

U. S. GEOLOGICAL SURVEY Water Resources Investigations Report 85-4232
Prepared in cooperation with the YAKIMA INDIAN NATION

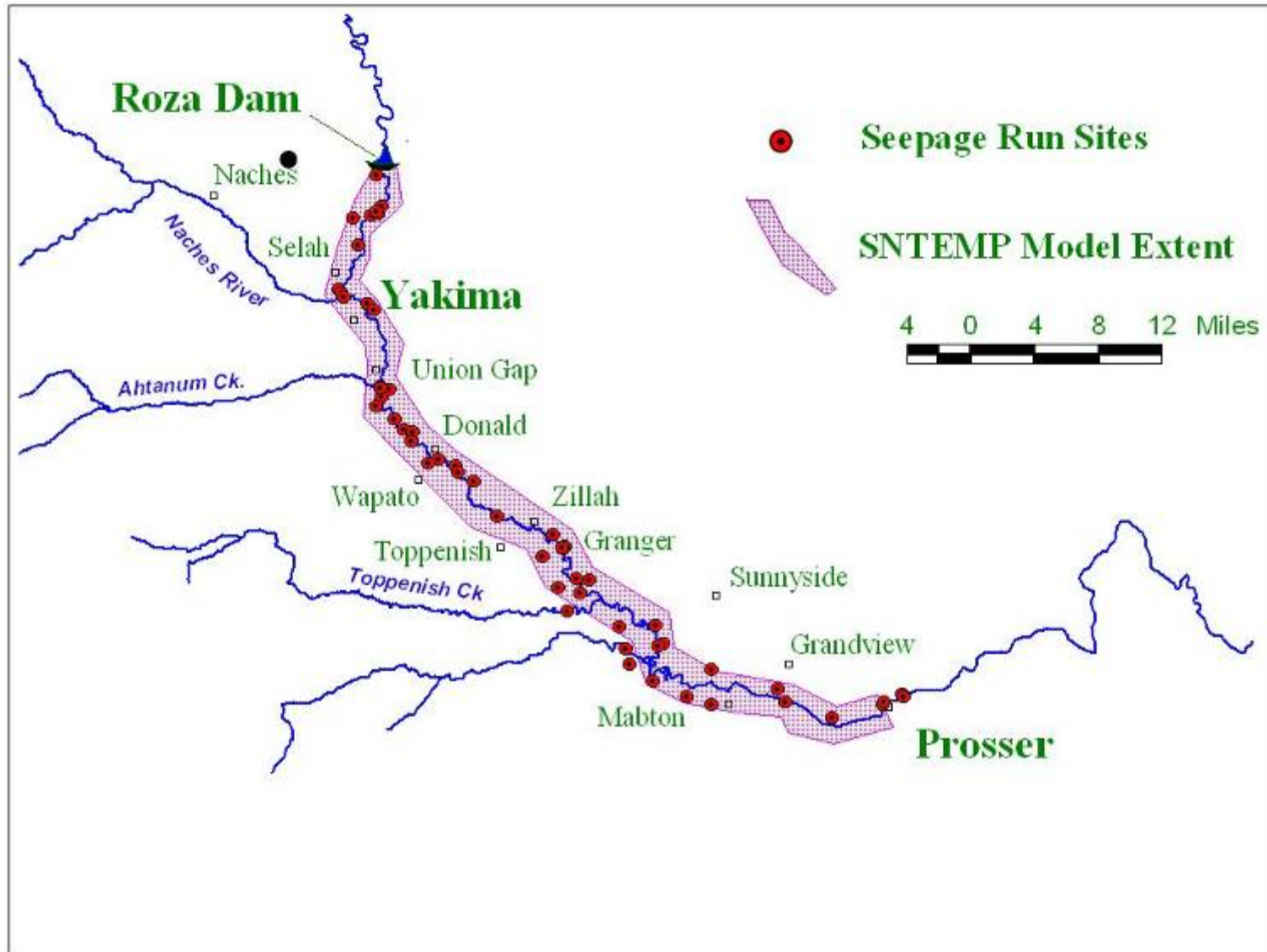


- Effect of reservoir outflow temp. diminishes downstream (4°C increase, 1°C increase at Umtanum and 0.01°C increase at Prosser)
- Influence of air temp. increases downstream and dominates in lower basin (4°C increase, 2.34°C increase at Prosser and 1.46°C increase at Umtanum).
- Wind had little effect on water temperature.

SNTEMP Model Extent



Seepage Run Locations



Continuous Data Collection

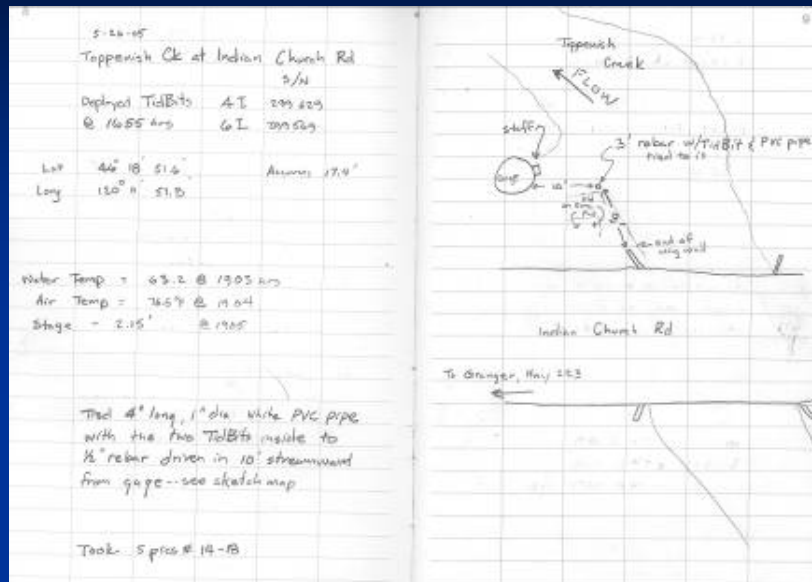
Tidbit Water Temperature Sensor



Near-River Met Towers—wind, solar radiation, air temperature, and relative humidity



Toppenish Creek at Indian Church Rd. 5/26/05



Thermal Profiling Equipment

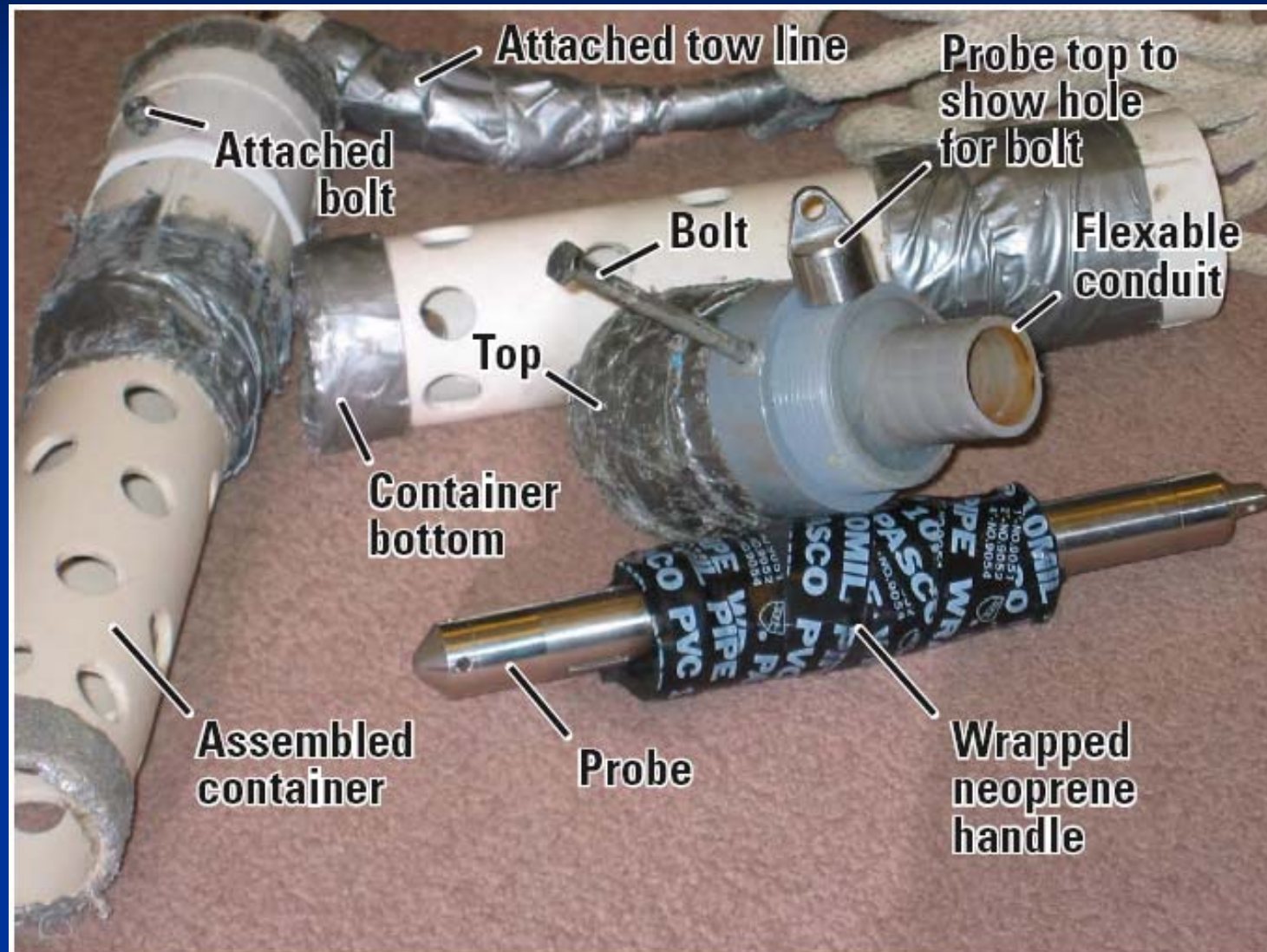
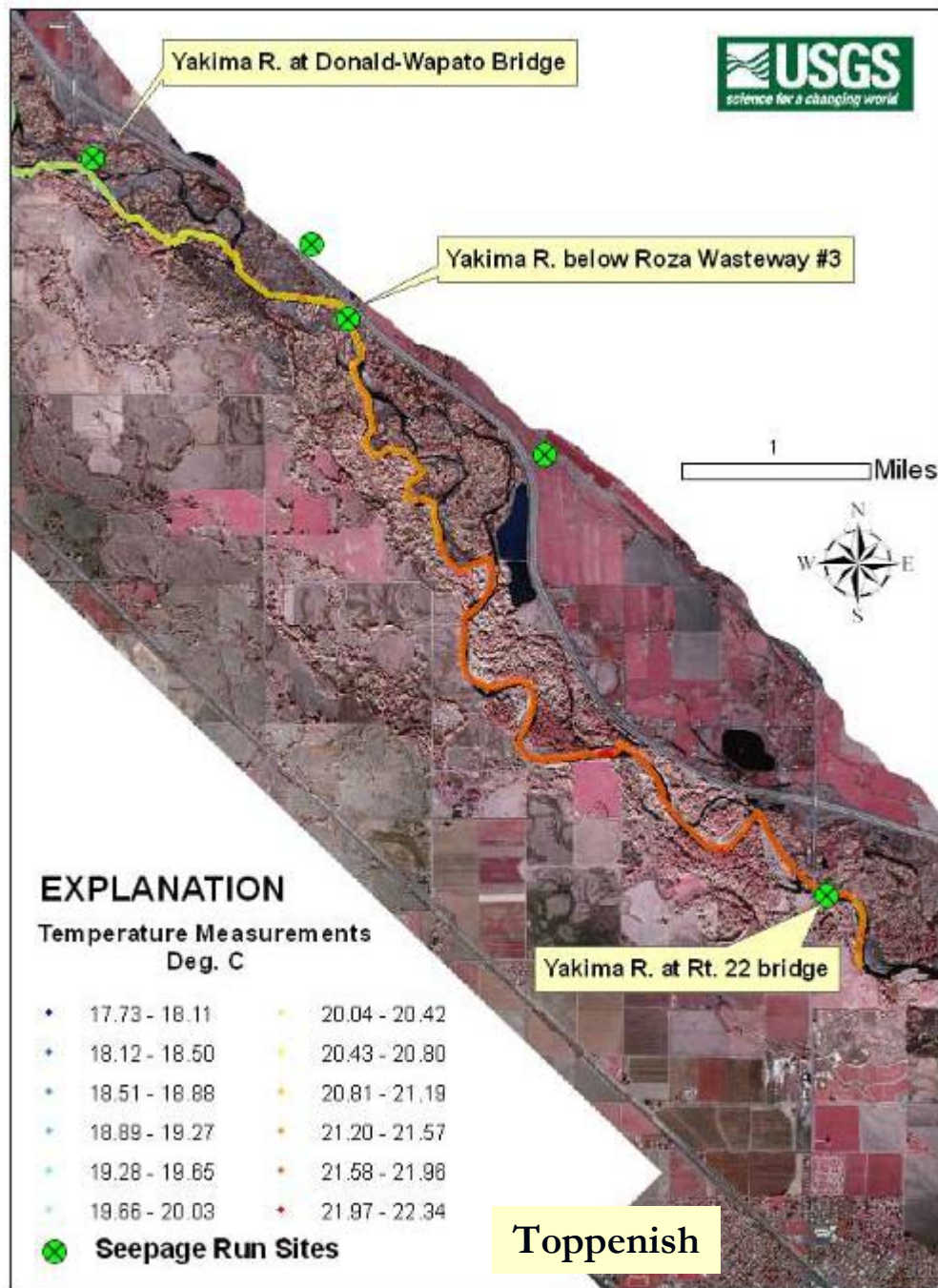
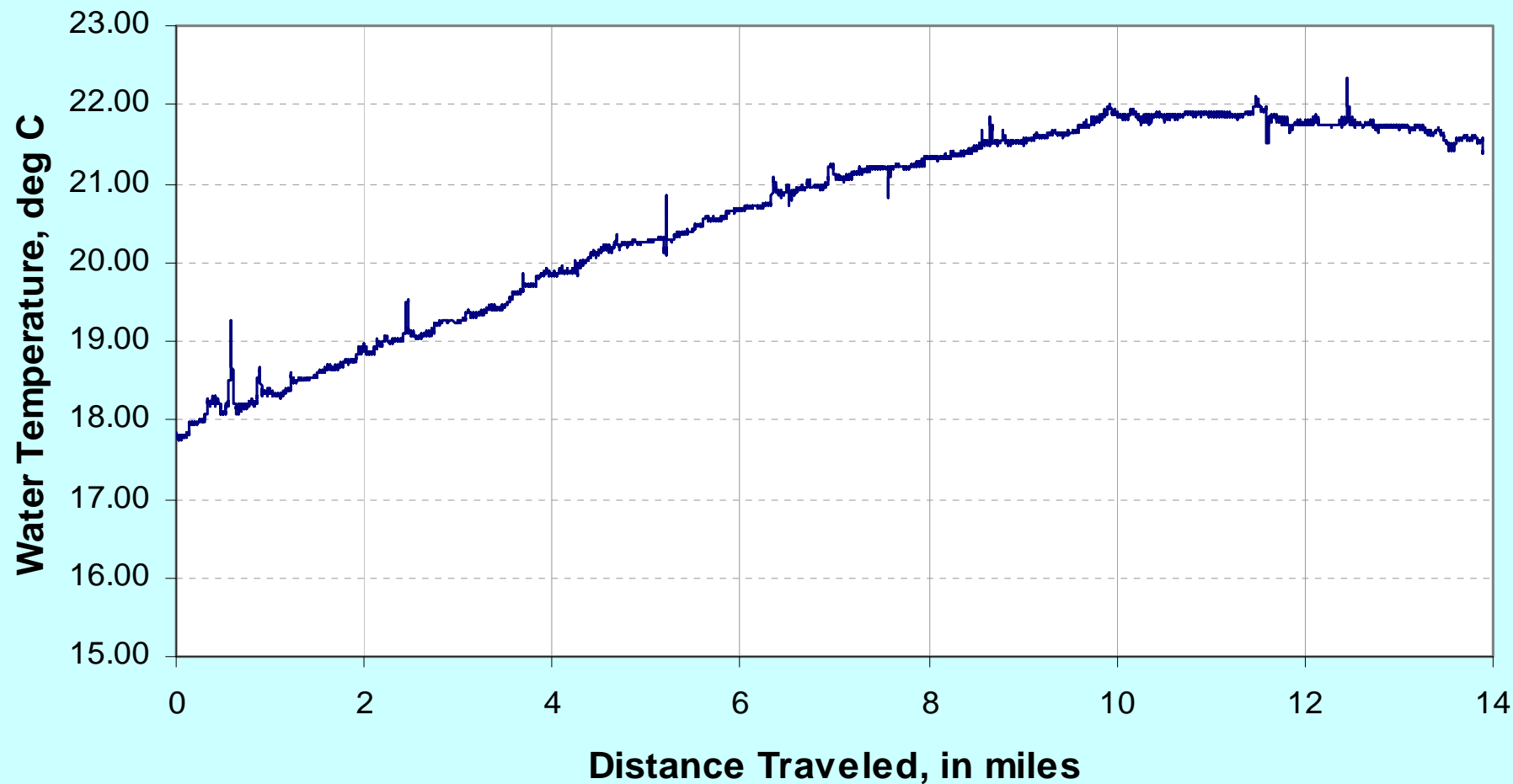


Figure 2. Temperature probe, container, and partially disassembled container.

Temperature Profile-- Parker Reach



Parker Reach-Thermal Profile



Mile 10 on Parker Reach Thermal Profile, 21.9 degC

21.86 degC

River Mile 95

21.75 degC

EXPLANATION

Temperature Measurements Deg. C

21.41 - 21.50	21.89 - 21.97
21.51 - 21.60	21.98 - 22.06
21.61 - 21.69	22.07 - 22.15
21.70 - 21.78	22.16 - 22.25
21.79 - 21.88	22.26 - 22.34

Temperature Profile-- Parker Reach

MainStem Seepage Run Results

River Mile	March '06 Gain/Loss	Sept. '05 Gain/Loss
103.6 (Yakima R. at Parker)	--	--
102.7 (Wapato Wells)	46	45
100.3 (Donald-Wapato Bridge)	90	-37
98.0 (Roza Wasteway #3)	-176	
93.1 (Rt. 22 Bridge)	240	163
86.0 (blw. E. Toppenish Drain)	123*	
83.8 (nr. Granger abv. Sub Drain 35)	-30	-37
82.9 (Hwy. 223 Bridge)	60	-13
75.6 (Yakima R. blw. Toppenish Ck.)	-144	-1

*From Roza Wasteway #3

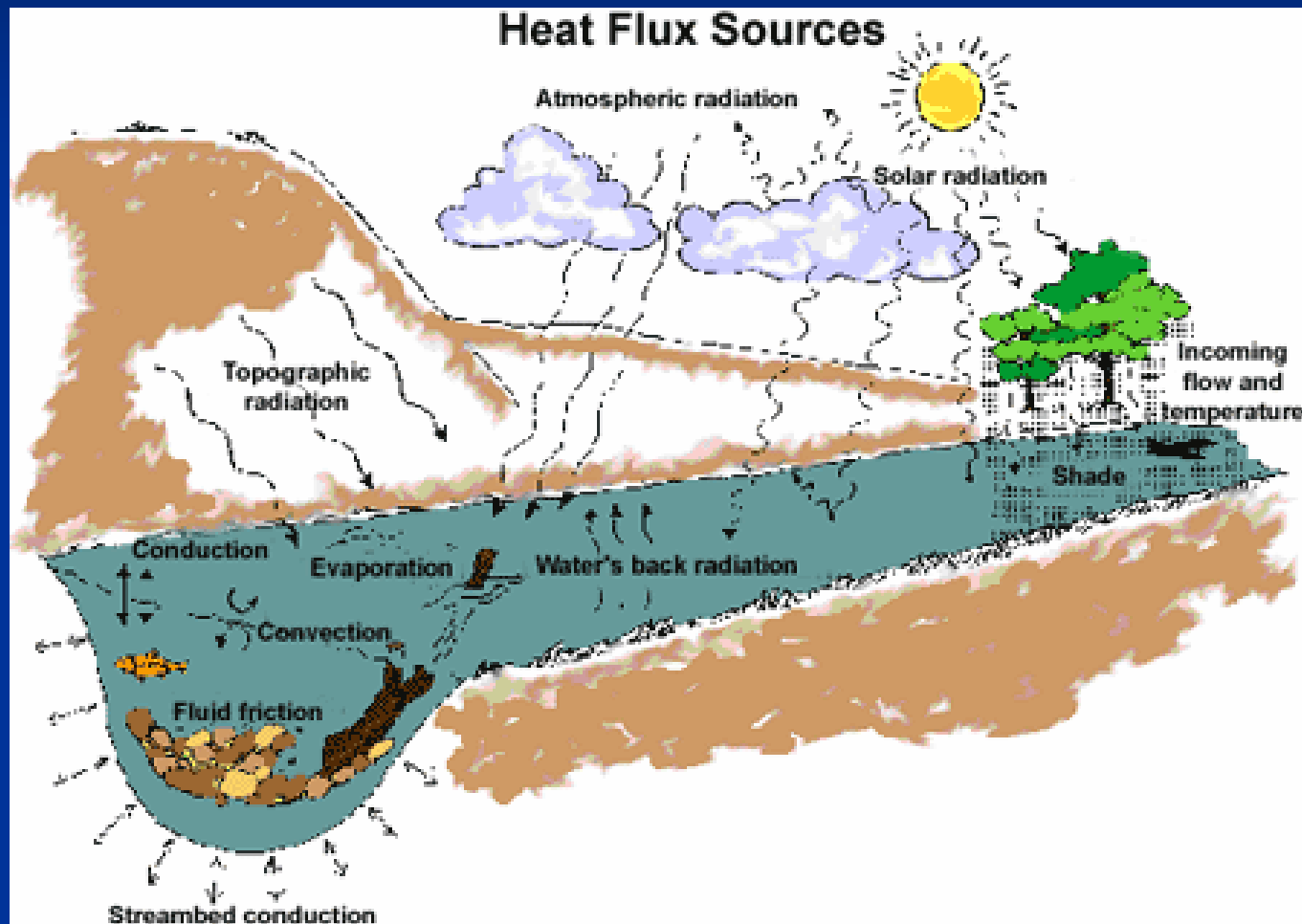
Yakima River Temperature Modeling— Approach

1. Simulate daily maximum water temperature for three 20-year scenarios to model the effects of storage alternatives.
2. Empirically determine water temperature at Roza Dam and Mouth of Naches River (boundary conditions) for given discharges.
3. Construct an SNTemp water-temperature model for the Mainstem Reach. SNTemp needs:
 - Water temperature and discharge for inflows and outflows
 - Shading data, Channel Width versus Discharge
 - Meteorological data
 - Air temperature
 - Wind
 - Solar Radiation

Yakima River Temperature Modeling— Approach, continued

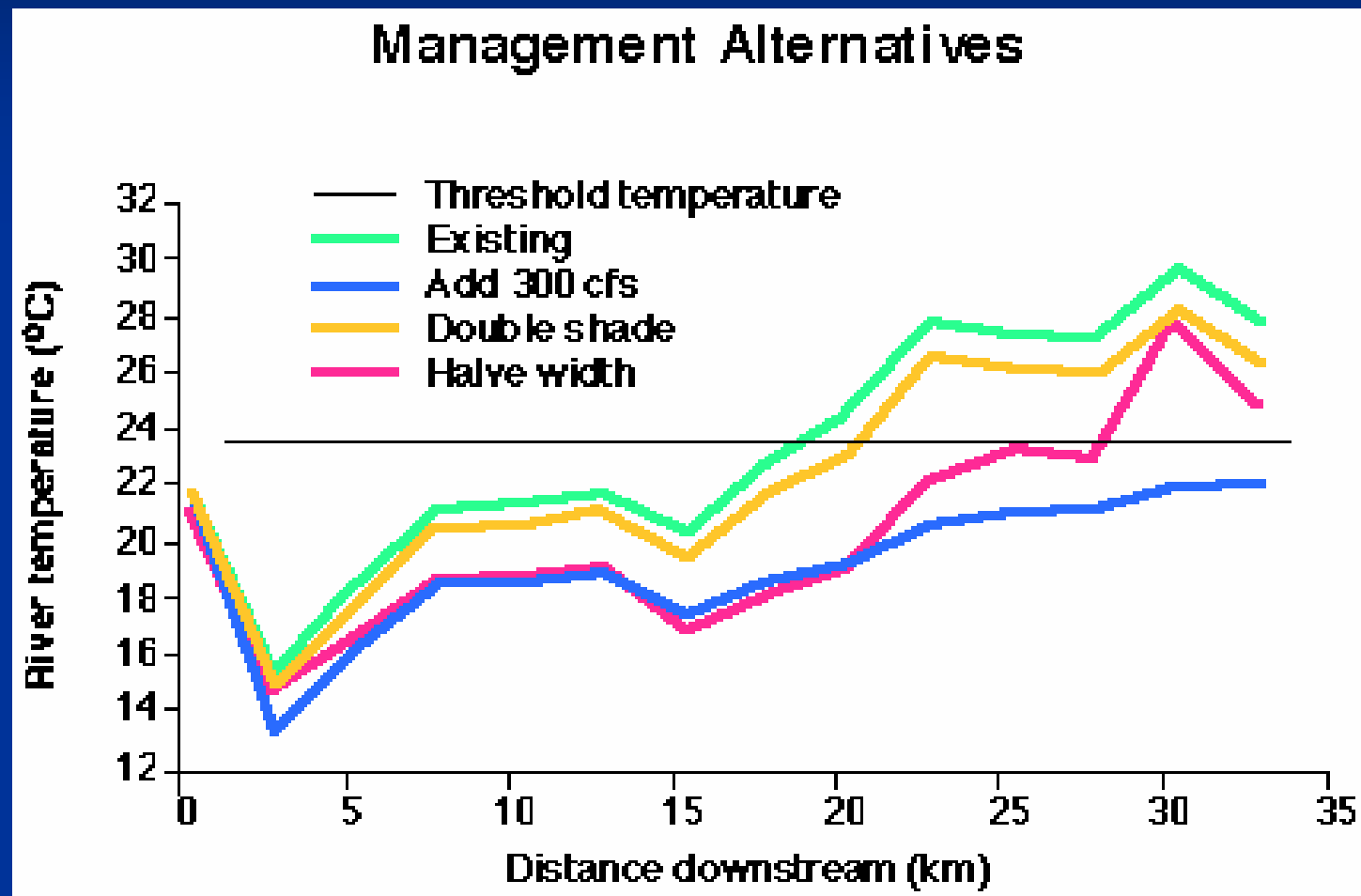
4. Collect water temperature data at a number of the larger tributaries and returns
5. Conduct seepage runs to compute ground-water inflow and water balance along mainstem reach, tributaries and returns
6. Calibrate SNTTEMP model with '05 WY data
7. Model Evaluation with temperature data collected through Sept. '06

SNTEMP—Water Temperature Model

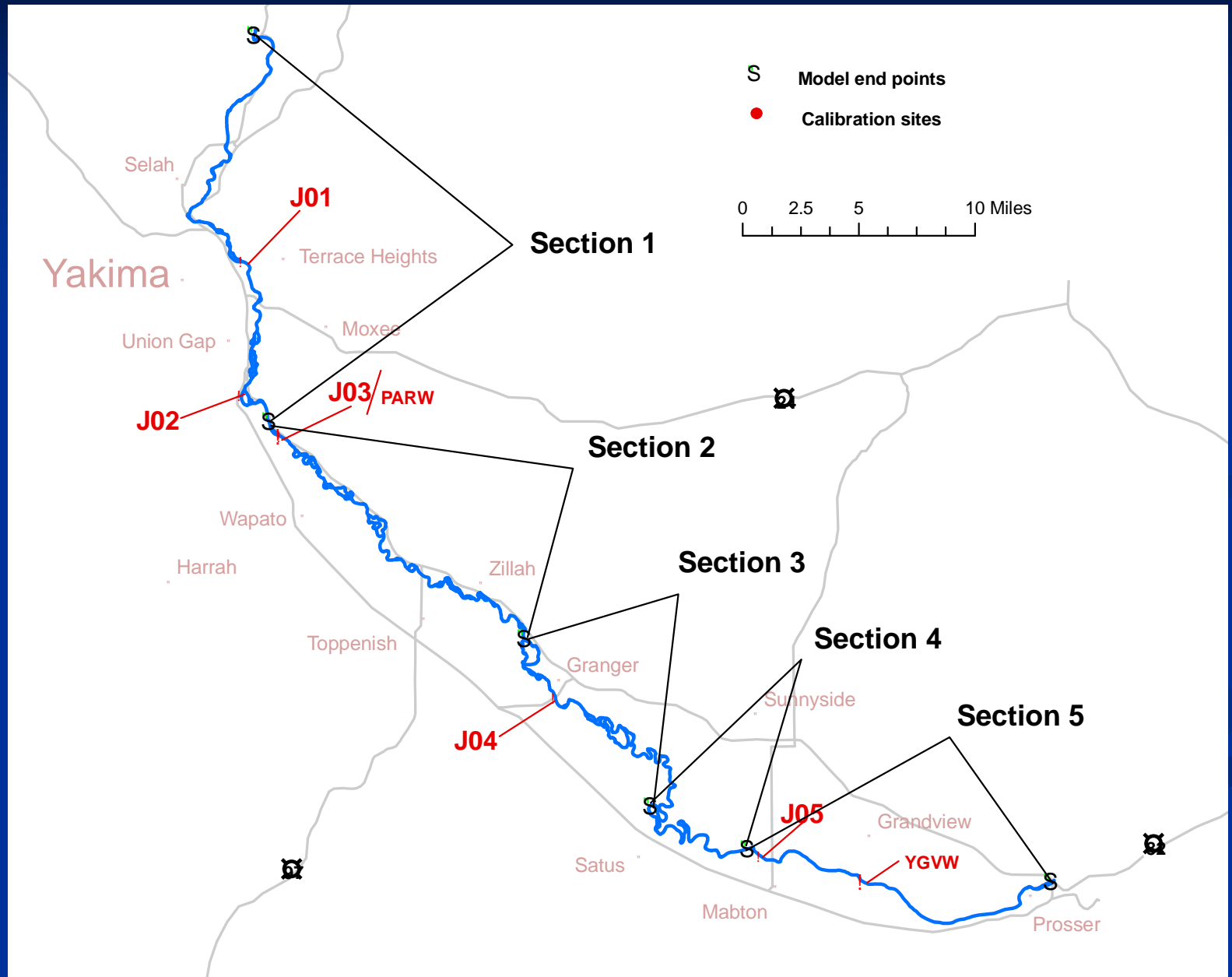


- 1D
- Daily Time Step
- Net Heat Flux
 - long- and short-wave solar radiation
 - convection
 - conduction
 - evaporation
 - shading
 - streambed friction
- Groundwater influx
- Steady-flow transport

SNTEMP—Water Temperature Model



Five SNTEMP Models in Series



Model Diagram

Section 1

Section 2

Section 3

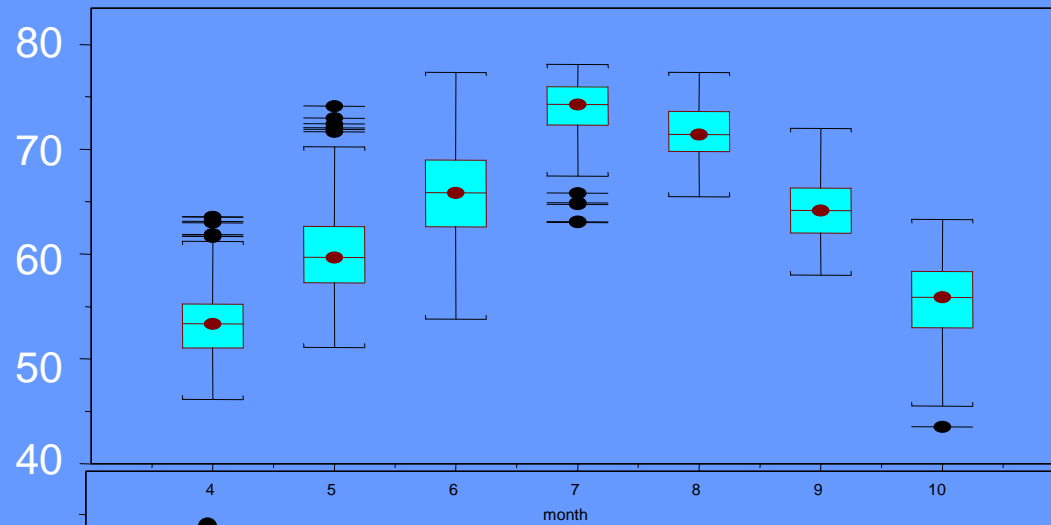
Section 4

Section 5

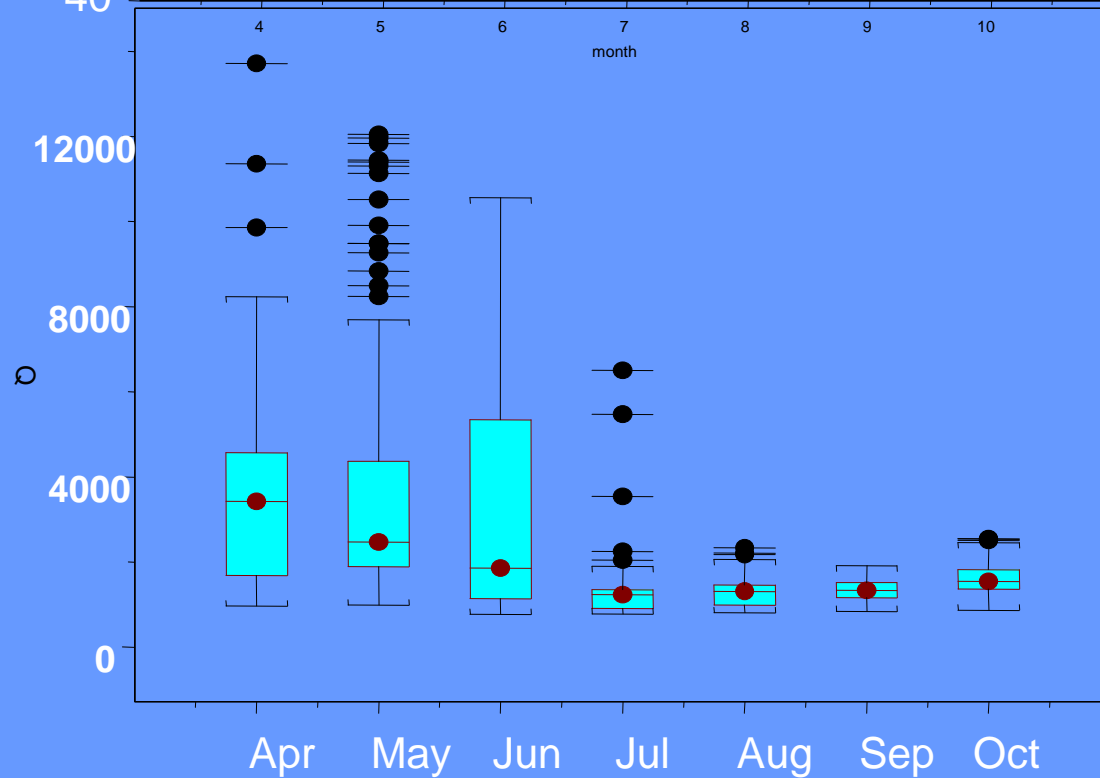
path e:\temp3\model\diagram\temp3_diagram_seep05_new.xls		river
inflow	outflow	distance kilometers
RDR - Roza Reservoir		
(RBDW - RZCW) - below Roza Dam: river kilometer 213.18		#NAME?
	SEXW Selah-Moxee Canal	213.00
Selah Creek at Canyon Rd. Crossing nr. Pomona		206.99
		206.53
Wenas Creek nr Mouth on USBR land nr. Selah		204.66
		204.45
Golf Course and Selah Sewage Outflow Creek nr Selah	Taylor Ditch at Harrison Rd. Bridge nr. Selah	204.05
NRYW - Naches River near Yakima		195.74
		194.46
		194.46
	Moxee Canal	192.86
	Hubbard Canal	192.82
	UNGW - Union Gap Canal	192.24
	Richartz Ditch	192.08
BICW Moxee Drain at Thrope Rd.		189.63
(RZCW-ROZW) Roza Wasteway #2 (at USBR)		189.60
	J01 - Roza Wasteway	0.00
		184.25
Wide Hollow Cr. Nr. Mouth		180.25
Union Gap Canal Wasteway		179.88
Ahtanum Cr. At Union Gap Sta. No. 12502500		179.20
	J02 - Moxee Drain at Thorp Road	0.00
	RSCW - New Reservation Canal	178.62
		174.92
PARKER - Parker Bridge Road bridge: river kilometer 174.91		#NAME?
	SNCW - Sunnyside Canal	173.71
	PARW - Yakima River near Parker	173.37
	J03 - Yakima R @ Donald-Wapato Bridge	173.00
		168.42
Roza Canal Wasteway No. 3		163.61
	Snipes and Allen Ditch Diversion	161.40
Lateral 1 near the Donald-Wapato Road near Wapato		151.44
		150.69
Roza Canal Wasteway No. 4		144.82
Roza-Sunnyside Joint Drain 19.9		143.00
Roza-Sunnyside Joint Drain 20.8		142.60
E TOP - abv East Toppenish Drain: river kilometer 142.40		142.40
East Toppenish Drain at Wilson Rd. Sta. No 12505350		142.38
DID Drain 27 at Mouth		136.91
Sub-Drain No. 35 at Parton Rd, Sta. No. 12505410		136.30
Granger Drain at Sheep Barns, Sta., No. 12505460?		135.61
	J04 - Yakima River above and near Granger bridge	135.30
Marion Drain at Indian Church Rd at Granger, Sta 12505510		135.25
		133.55
		132.59
Toppenish Ck. at Indian Church Rd, Sta. 12507508		132.29
		128.66
Coulee Drain nr. Satus Rd Crossing (2 Drains?)		124.92
DID 16 Drain		117.66
SATUS - @ mile 70. river kilometer 114.16		#NAME?
Satus Ck. at Satus (at gage), Sta. No. 12508620		113.67
South Drain nr Satus, Sta. No. 12508630		113.22
		112.44
Satus No. 2 Drain		108.94
DID No. 7 Drain		104.77
Satus No. 3 Drain		101.63
SULPHUR - abv Sulphur Creek Wasteway: river kilometer 99.57		99.57
SUCW -- Sulphur Cr. Wasteway		99.36
		98.17
Satus Drain 303 + Mabton West Wasteway at Hwy. 22		98.07

Monthly water temp. and flow at Yakima R. at Grandview, WA

Water
Temperature
(F)



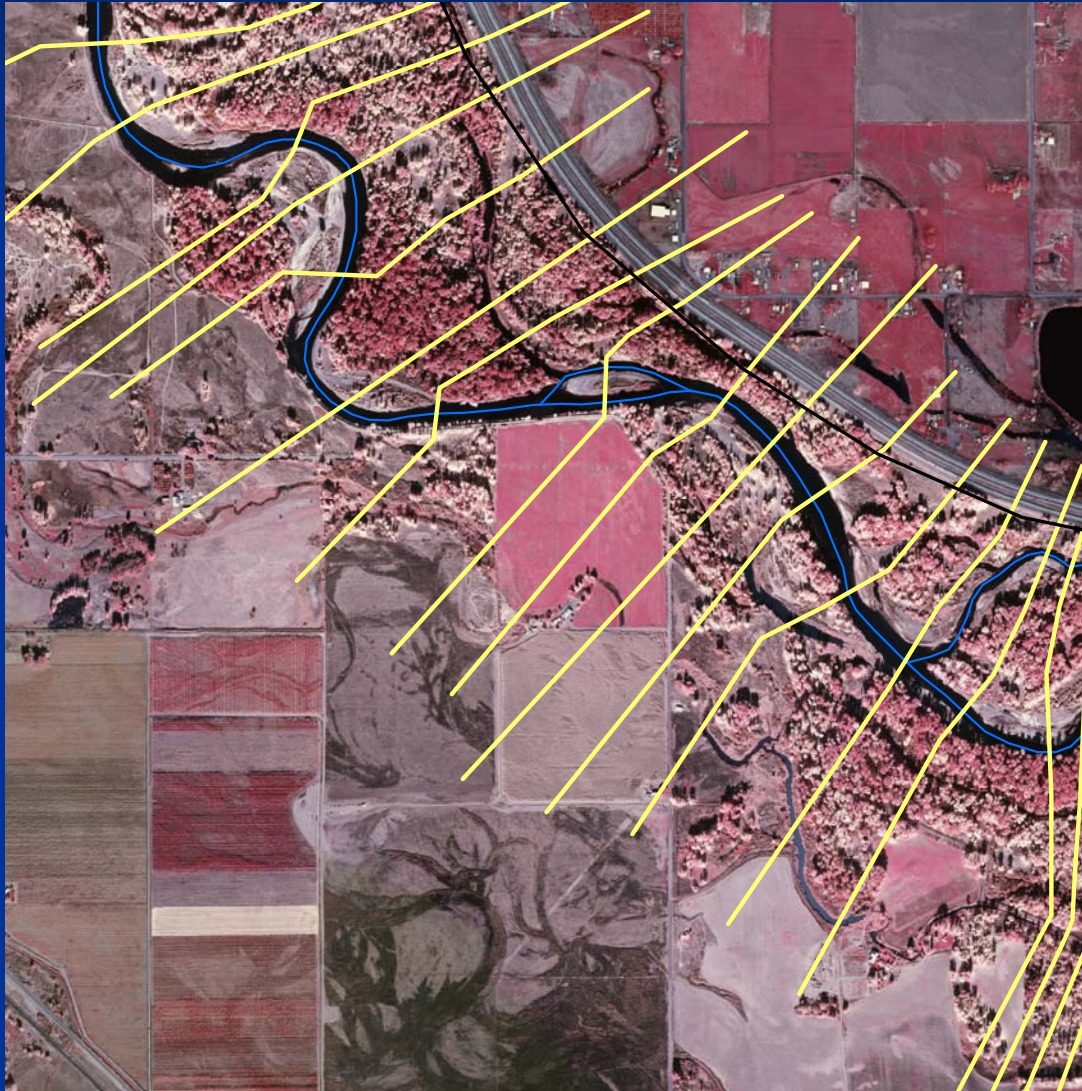
Flow (cfs)



Water Temperature Response to Meteorology Inputs (preliminary results)

Parameter and % increase	% change in Daily Max. Temp. for 2005				% change in Daily Mean Temp. for 2005		
	Site J4		Site J5		Site YGVW		
	Season	July	Season	July	Season	July	
Air Temperature +5%	1.71	2.02	1.72	1.95	2.03	2.47	
Solar Radiation +5%	1.31	1.62	1.40	1.56	1.22	1.65	
Relative Humidity +5%	0.61	0.81	0.62	0.78	0.76	0.82	
Wind Speed +5%	-0.24	0.00	-0.26	-0.39	-0.28	-0.41	

HEC-RAS x-sections for width-flow relationship



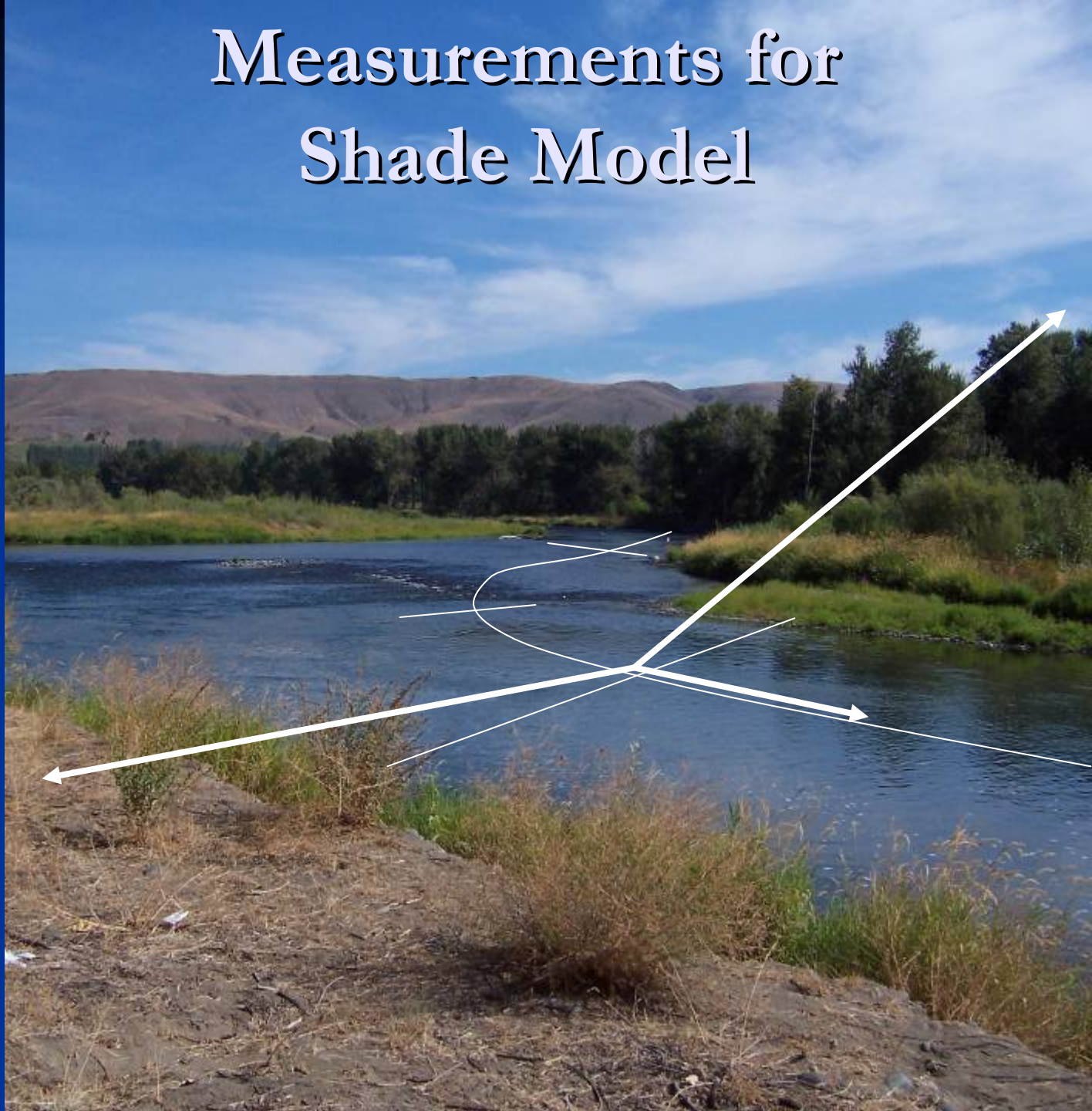
$$W = a * Q^b ;$$

where W is width
Q is discharge,
and a and b are
coefficients

Measurements for Shade Model

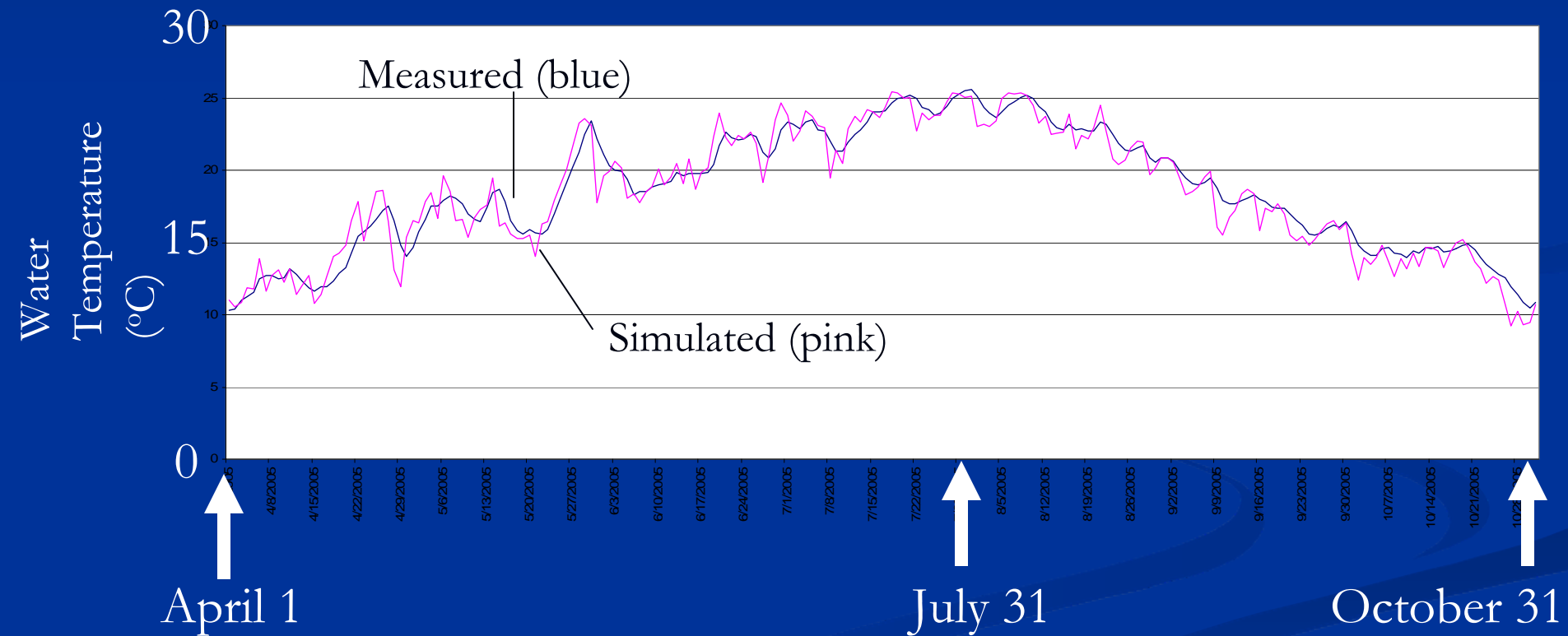
For each site

- Latitude
- Azimuth
- Stream width
- Topographic
Altitude
- Vegetation
 - Height
 - Offset
 - Density



Simulated and Measured Daily Average Water Temperature

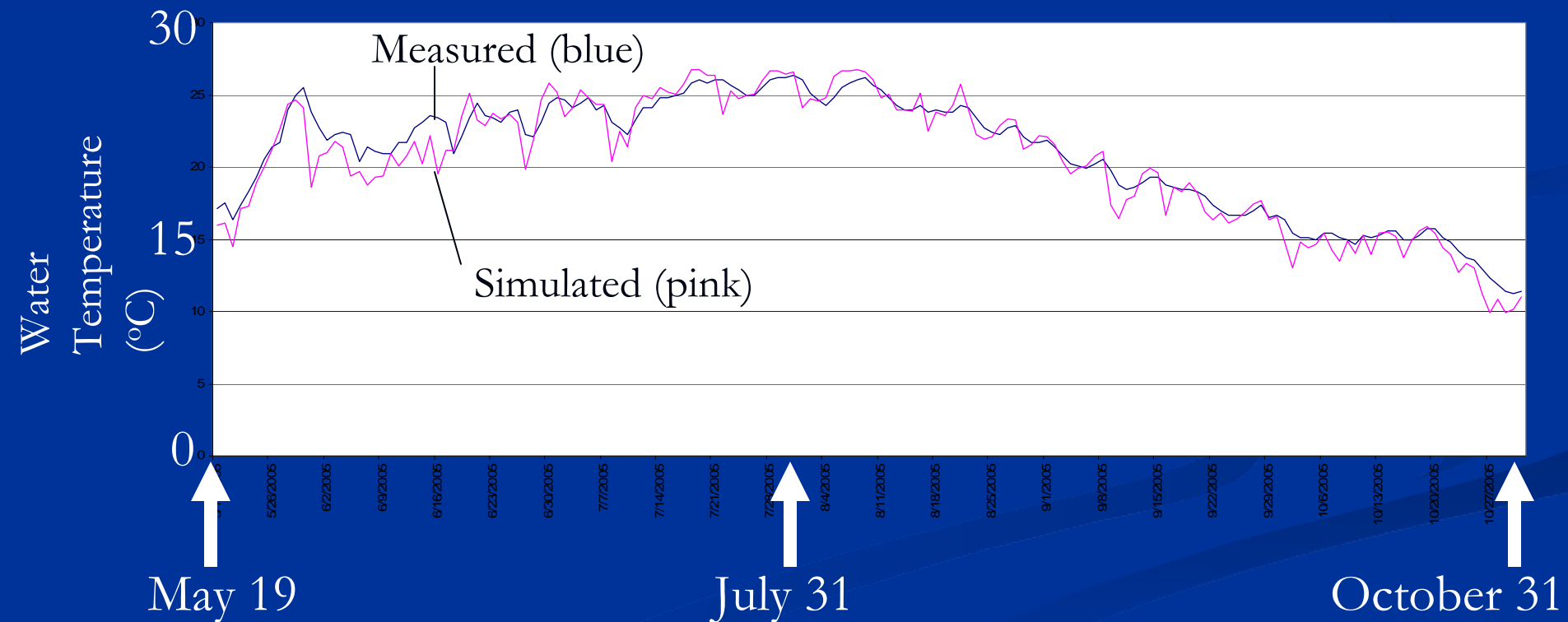
Gage on Yakima River at Grandview, WA
YGVW



Simulated and Measured Daily **Maximum** Water Temperature

Tidbit sensor on Yakima R. at Mabton bridge

J05



Model Summary

- Water temperature most sensitive to changes in air temperature and solar radiation, more sensitive during periods of low flow
- Shading may cool water temperature 0.5 C in upper sections, less than 0.5 C in lower sections
- Model simulated seasonal patterns for 2005
- Error high when predicting daily values